LONG RANGE TESTING of the SILVER MOUNTAIN TARGET SYSTEM WITH PERFECT SETUP

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with considerable help from
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A fifth and final series of tests of the Silver Mountain electronic target system was conducted at the Wongetti Rifle Range in Cairns on the 27th October 2017 to provide performance data of the system at 800 metres.

The testing procedure was identical to that used in all the previous tests and is explained in full in the document “Procedure” available at

https://sites.google.com/site/targettests2016/home/procedure

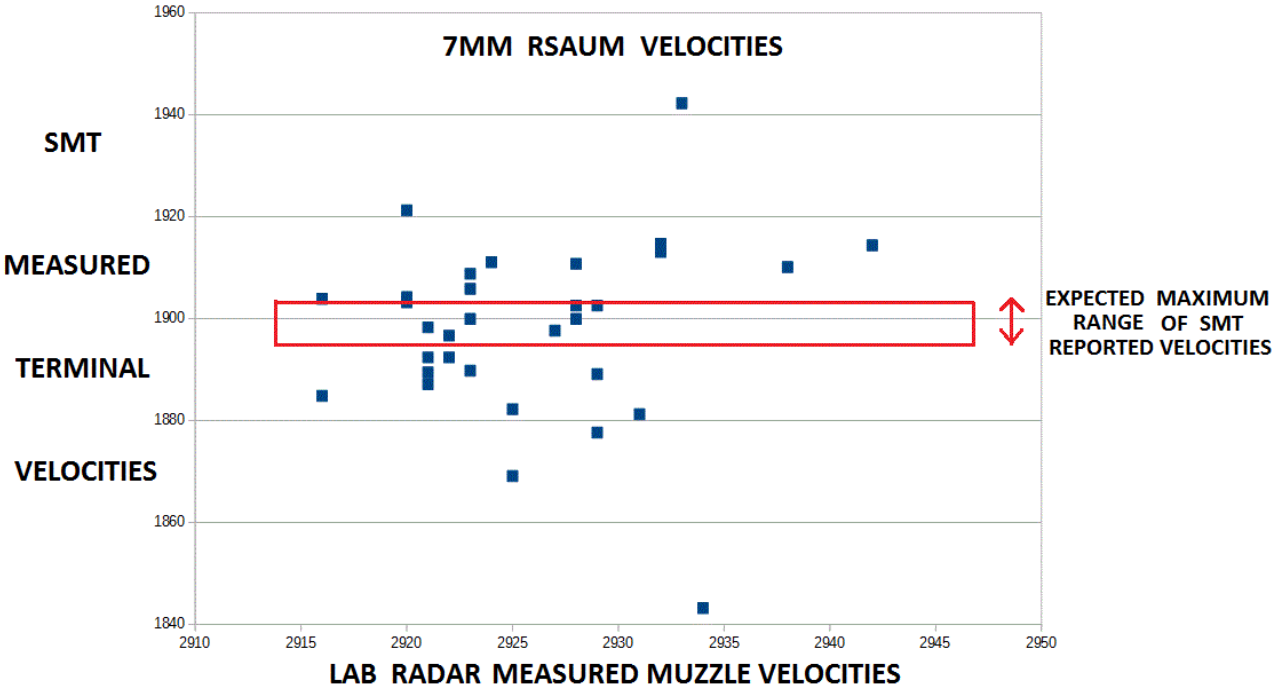
The Silver Mountain system was mounted onto a Hexta target and while at first glance this might suggest that one manufacturer's system was used to test that of a competitor this is **NOT** the case. The actual shot positions are recorded on a corflute test sheet and each system is independently evaluated against that data.
Previous testing has demonstrated the necessity for perfect set-up of the SMT to achieve best results and the rigid construction of the heavy Hexta target makes an ideal platform for this, eliminating any bending, twisting or warping.
Mounting on the Hexta target also allowed the concurrent testing of both systems, saving the testing team a lot of time and expense.

The Cairns range was surveyed to determine both the horizontal and vertical angles of the firing point relative to the target and the necessary corrections of 8mil and 47mil respectively were entered into the SMT G2 unit. The temperature sensor was compared to a mercury laboratory thermometer in a shaded area prior to the testing and the appropriate compensation set in the unit.
With the sensors attached to the target and the chronograph sensor shimmed to be at 90º to the face both horizontally and vertically, the target was locked in the raised position and held exactly vertical with guy ropes and ratchet straps.

All testing was conducted at 800 metres with the target calibrated using four shots of .308 calibre. There followed three individual tests of at least thirty shots each which were fired using a .308 Winchester with 155.5gn Berger projectiles , a .223 Remington with 80gn Sierra projectiles, and a 7mm RSAUM with 180gn Berger projectiles. Muzzle velocities were recorded on a LabRadar.

As a check of the quality of the set-up, Silver Mountain recommend comparing the terminal velocity as recorded by the system to the velocity predicted by a ballistics calculator. The average of the terminal velocities for each series agreed almost

exactly with that predicted, indicating a very good set-up of the system. It should be appreciated that averaging the velocity of 30 shots is a very powerful tool and a few shots averaged is unlikely to be very useful.
There was far too much variation to allow comparison of individual shots which may be appreciated from the following graphic.



Weather on the day was fine with a temperature of 30ºC and with absolutely no wind.

Results

The measure used in assessing the precision of an electronic target is the linear distance between the actual position of the shot and the reported position after the centring error has been removed and so is always positive. A comprehensive set of results for each test is contained in the final pages of the report.

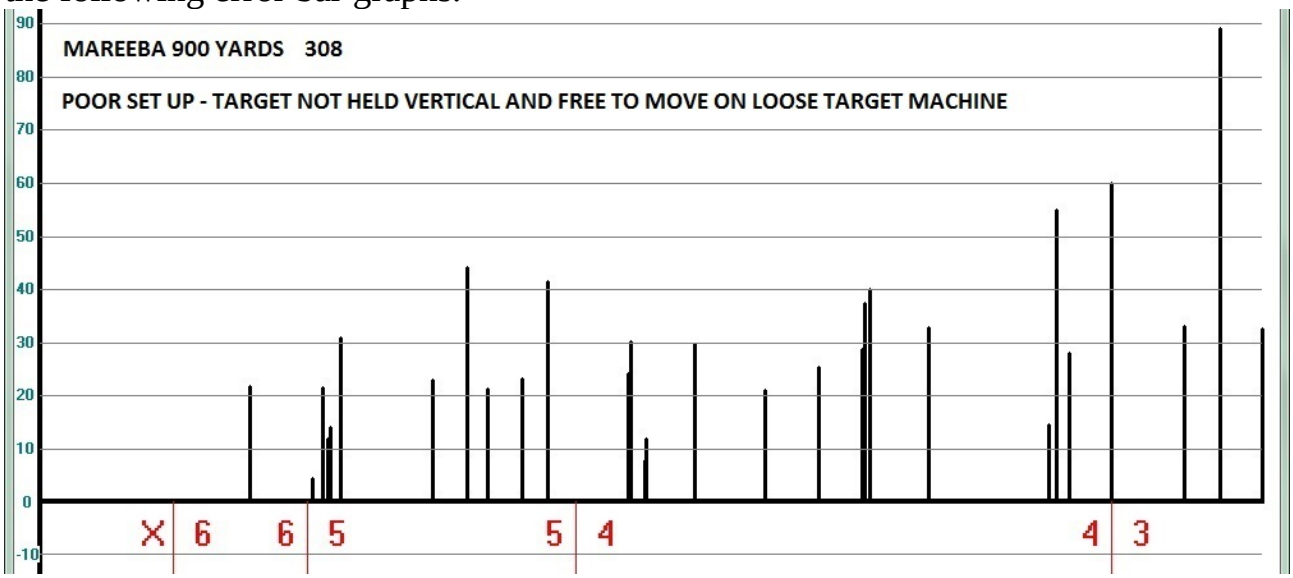
Discussion of the results of these tests has to begin with the final test of the day and more particularly with one shot in the sequence. Shot 17 with the 7mm RSAUM produced a massive error of **924mm** and there is absolutely no doubt that the figure is genuine.
Through exhaustive checking and rechecking of data a possible explanation has emerged for this huge outlier. As mentioned previously we were conducting concurrent tests on the Hexta system and the next target in line was also being tested with the 308 at the same time. A check through the Hexta system log showed an identical time stamp for this shot 17 and a shot on the neighbouring target and it is likely that the open SMT system has combined the shock waves from the two shots even though the targets were separated by a metre.

There are a couple of general trends that have been evident through all the tests and the first of these is a sensitivity to the terminal velocity of the projectiles as shown in the table below.

Rifle Calibre		7mm RSAUM		308 Winchester	223 Remington
Average Terminal Velocity	feet/sec	1898		1513	1406
SD x	(mm)	7	(92.1)	9	10.6
SD y	(mm)	4.9	(132.2)	9	9.4
Mean Linear Error	(mm)	7.8	(56.8)	11.5	12.5
Linear error SD	(mm)	3.6	(150.8)	5.6	6.6
Max linear Error	(mm)	14.7	(924)	22.6	31.4

These values calculated **WITHOUT** shot 17 included. The numbers in brackets include shot 17. Because of the way the centre shift is calculated this single error distorts the results for the entire test and makes it difficult to convey the general pattern that is evident in all the series of tests we have conducted. **Actual maximum error was 924 mm.**

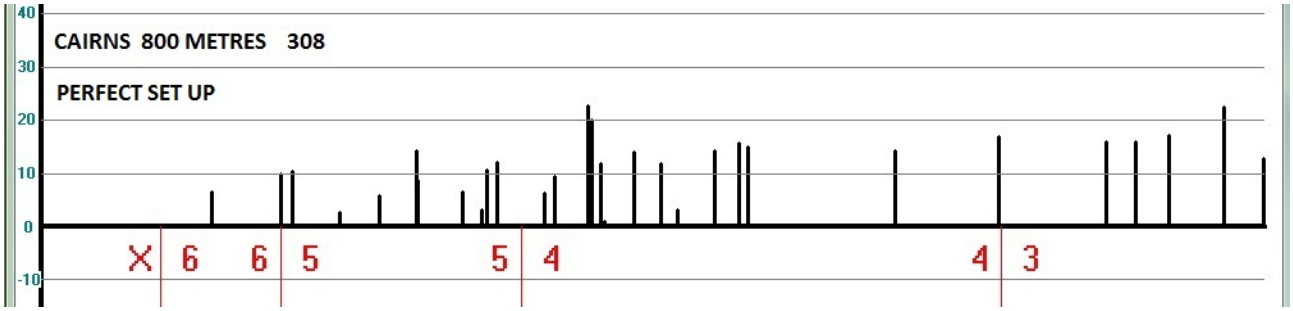
By far the most important influence on the precision of the Silver Mountain system is the way it is set up and every aspect of the set up needs to be as close to perfect as possible. Any deviation of the shooting angle from 90º in either the horizontal or vertical plane needs to be measured and the appropriate correction entered into the system; the chronograph element incorporating sensors one and three needs to be attached to the target at right angles in both axes; and most important of all the target itself needs to be vertical and held absolutely rigid, as any movement degrades the precision of the system. The effect of inadequate set up is graphically illustrated in the following error bar graphs.



MEAN ERROR:29.5mm SD:16.6mm

For this test the chronograph was aligned according to the Silver Mountain instructions but no other improvements to set up were attempted. The target was of light construction and mounted on an old pit based machine typical of most of the older ranges in Australia.

The graphic below illustrates the final test where the set up was as close to perfect as we could get it in all areas and is unlikely to be matched on any operating range. The Target frame was held rigidly perpendicular with ropes and straps.



MEAN ERROR:11.5mm SD:5.6mm

The other critical factor, acknowledged by SMT, is that the terminal velocity must be significantly higher than the speed of sound. The difference in target precision with faster bullets is evident both above and in the following detailed data.

The ammunition used in these tests was influenced by the temperature as it was a ‘winter’ load and velocity was higher than expected on this very hot tropical day. The 223 was also shot from a 30 inch target barrel. At 1000 yards, for example, typical 223 terminal velocity would be very significantly reduced with a probable consequent reduction in target precision. This is a prediction only, based on the trends observed, and needs to be confirmed in tests by shooters with access to a Silver Mountain system and a 1000 yard range.

Finally, remember that there was no wind during the tests so the performance measured should represent the best that the SMT can deliver.

Details of the tests follow in our usual two page per test format.

This is best viewed on a large screen with two pages side by side.

SMT CAIRNS 223-800m 31 SHOTS PERFECT SETUP

d	Ax	Ax SET	Ay	Ay SET	UPRIGHT	RIGID	Vo (LR)	Vsmt	Vcalc	Vo SD	Predicted Target V SD	SMT V SD
800m	8 mil	8 mil	47 mil	47 mil	PERFECT	PERFECT DEAD CALM	2914	1406	1399	12.5	8	19.0

X SPAN 829.69 mm
Y SPAN 815.26 mm
CENTRE FITTED REPORT
X CENTRE SHIFT 0.75 mm
Y CENTRE SHIFT -0.58 mm
Shown Further from Centre 3
Shown Closer to Centre 28
SDx 10.56 mm
SDy 9.44 mm
MEAN (mm) SD (mm)
LINEAR ERR 12.54 6.58

mean mean mean

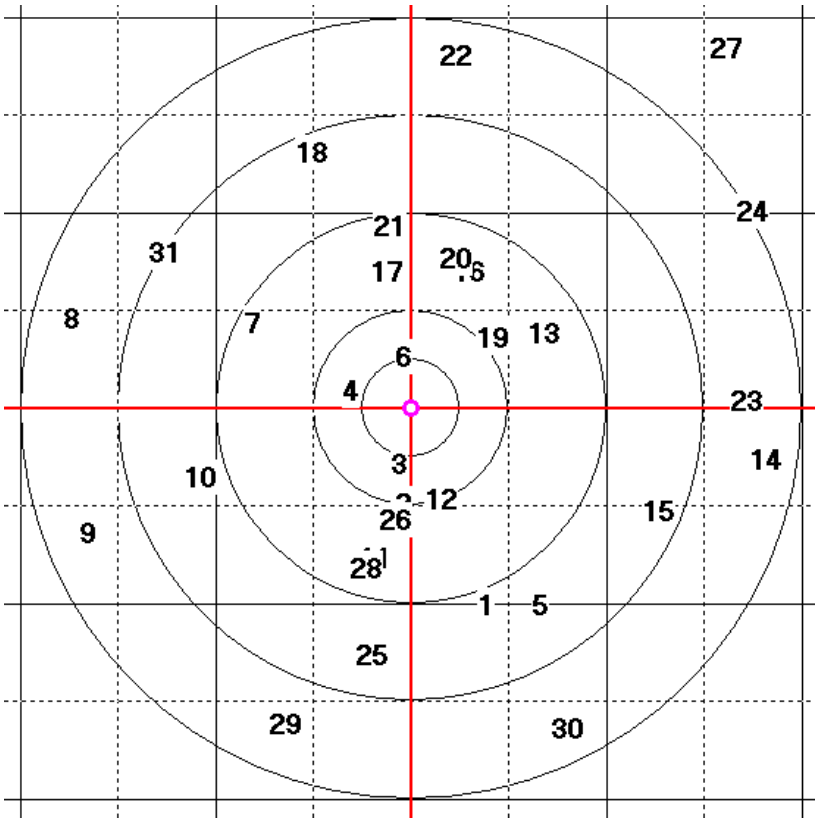
Sierra 80 grain SMK Projectile
SMT Temp 29-30 during firing

Fri Oct 27 2017

No	Impact X	Impact Y	Monitor X	Monitor Y
1	87.44	-227.12	75	-225
2	-10.57	-104.42	-4	-104
3	-16.96	-58.05	-9	-51
4	-74.72	29.94	-85	44
5	153.51	-226.08	151	-212
6	-11.42	71.06	-9	74
7	-192.1	110.64	-186	107
8	-407.96	116.57	-399	116
9	-388.62	-139.8	-381	-131
10	-254.74	-74.32	-254	-71
11	-46.05	-170.95	-46	-164
12	32.42	-100.45	27	-92
13	157	99.12	156	100
14	421.73	-52.69	396	-56
15	292.84	-113.98	283	-111
16	66.62	173.69	62	159
17	-32.34	172.16	-28	167
18	-121.47	316.21	-107	307
19	94.13	93.84	84	87
20	51.04	188.34	44	180
21	-28.73	227.78	-29	212
22	50.61	431.41	49	418
23	398.63	17.41	389	19
24	406.08	244.31	416	241
25	-50.1	-286.57	-44	-274
26	-22.22	-124.09	-15	-120
27	373.99	440.14	350	436
28	-56.08	-183.45	-50	-179
29	-153.01	-369.35	-145	-351
30	184.08	-375.12	167	-361
31	-297.8	194.9	-276	174

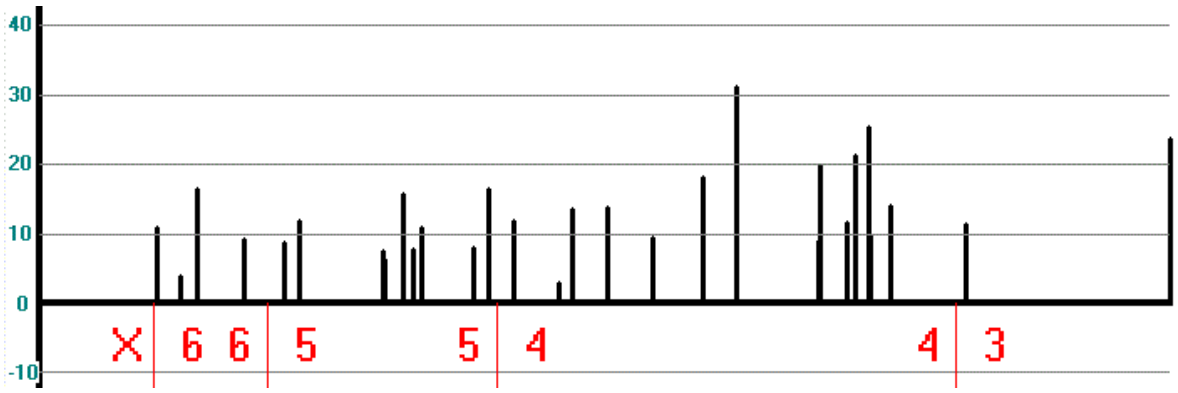
RAW MEASUREMENTS in mm

SHOT POSITIONS



Grid in minutes and half minutes (800m)

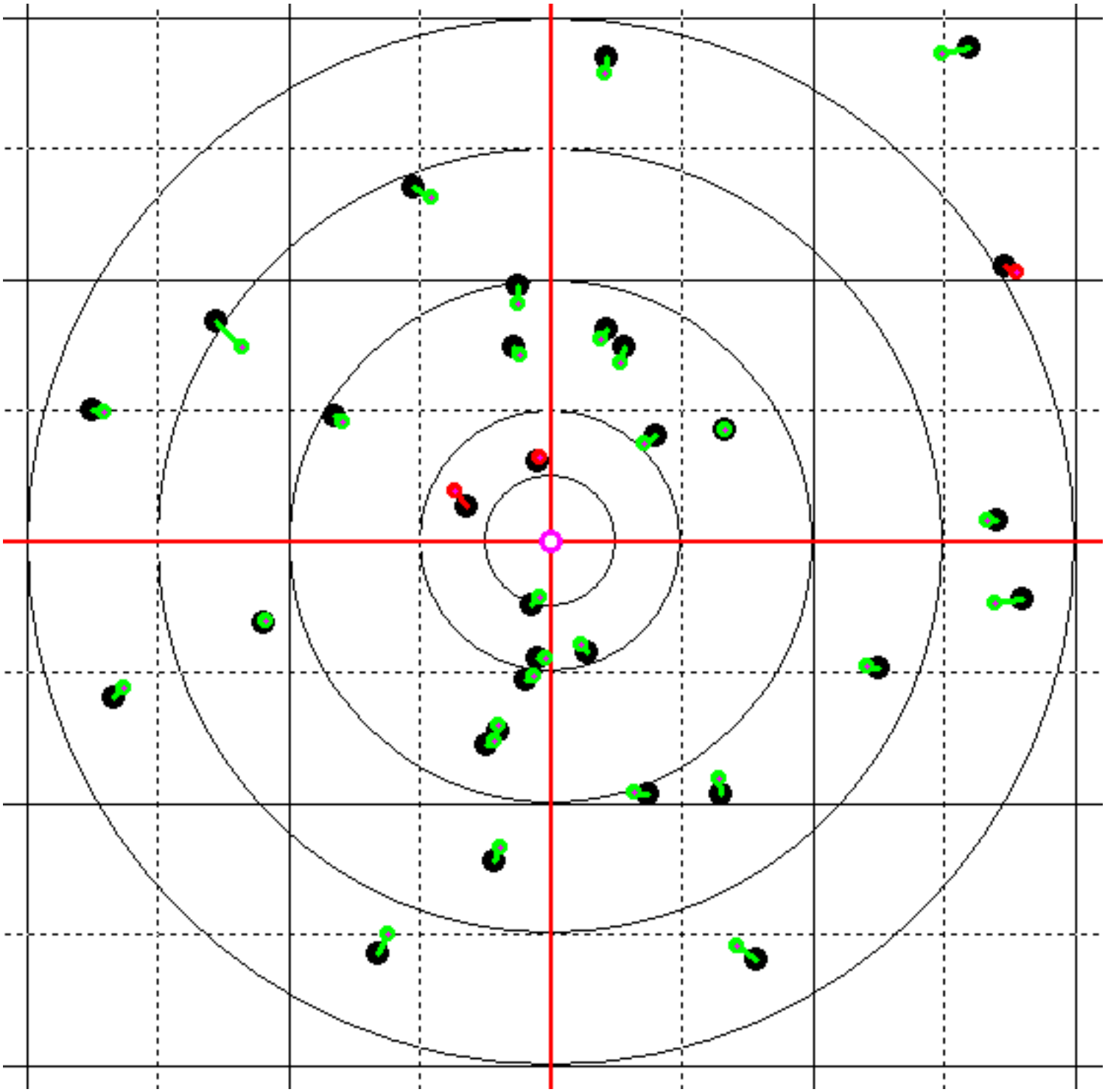
CENTRED ERRORS



X, 6, 5, 4, 3 indicate Score or how far shot is from the centre.

BARS ARE REAL ERROR SIZE

X err	Y err	R err	Lin err
-11.69	1.54	-4.46	11.79
7.32	-0.16	-1.49	7.32
8.71	6.47	-9.65	10.85
-9.53	13.48	12.66	16.51
-1.76	13.5	-12.56	13.62
3.17	2.36	0.78	3.95
6.85	-4.22	-7.99	8.04
9.71	-1.15	-9.7	9.78
8.37	8.22	-10.67	11.73
1.49	2.74	-2.22	3.12
0.8	6.37	-6.26	6.42
-4.67	7.87	-8.29	9.15
-0.25	0.3	-0.05	0.39
-24.98	-3.89	-24	25.28
-9.09	2.4	-9.26	9.4
-3.87	-15.27	-15.74	15.75
5.09	-5.74	-6.99	7.67
15.22	-9.79	-15.11	18.1
-9.38	-7.42	-11.76	11.96
-6.29	-8.92	-9.82	10.91
0.48	-16.36	-16.05	16.37
-0.86	-13.99	-14.01	14.01
-8.88	1.01	-8.86	8.94
10.67	-3.89	7.2	11.36
6.85	11.99	-13.21	13.81
7.97	3.51	-5.56	8.71
-23.24	-4.72	-18.22	23.71
6.83	3.87	-6.03	7.85
8.76	17.77	-19.8	19.81
-16.33	13.54	-18.75	21.21
22.55	-21.48	-30.21	31.14



Grid in minutes and half minutes (800m)

SMT CAIRNS 308-800m 32 SHOTS PERFECT SETUP

d	Ax	Ax SET	Ay	Ay SET	UPRIGHT	RIGID	Vo (LR)	Vsmt	Vcalc	Vo SD	Predicted Target V SD	SMT V SD
800m	8 mil	8 mil	47 mil	47 mil	PERFECT	PERFECT DEAD CALM	2940	1513	1501	10.6	7	15.2

X SPAN 1024.50 mm
Y SPAN 922.89 mm
CENTRE FITTED REPORT
X CENTRE SHIFT 4.07 mm
Y CENTRE SHIFT 4.59 mm
Shown Further from Centre 4
Shown Closer to Centre 28
SDx 9.04 mm
SDy 8.98 mm
MEAN (mm) SD (mm)
LINEAR ERR 11.47 5.55

mean mean mean

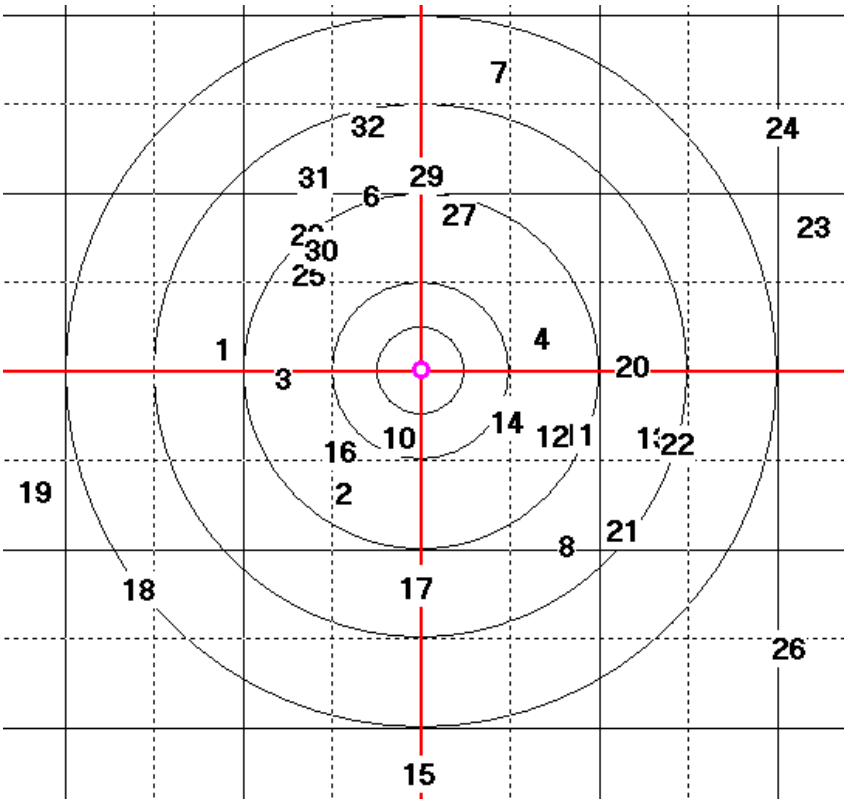
Berger 155.5 Fullbore Projectile
SMT Temp 29-30 during firing

Fri Oct 27 2017

No	Impact X	Impact Y	Monitor X	Monitor Y
1	-259.64	44.69	-260	41
2	-101.44	-145.33	-92	-145
3	-179.73	4.55	-175	0
4	160.02	58.57	151	51
5	111.95	-40.99	111	-55
6	-65.05	244.94	-60	243
7	102.75	408.61	101	390
8	192.37	-214.93	177	-211
9	-0.19	-263.69	6	-251
10	-28.88	-71.96	-32	-70
11	205.9	-67.95	204	-75
12	171.5	-69.59	158	-69
13	304.38	-71.92	297	-77
14	113.32	-51.28	100	-51
15	-3.44	-514.28	-7	-503
16	-107.33	-89.45	-114	-95
17	-7.37	-268.32	-21	-266
18	-372.11	-272.15	-363	-266
19	-508.5	-143.5	-497	-145
20	278.14	22.31	273	18
21	265.95	-193.3	250	-190
22	337.75	-80.67	320	-79
23	516	204	497	208
24	476.15	335.25	455	316
25	-148.64	141.96	-149	132
26	484.11	-348.84	469	-347
27	50.26	221.75	46	205
28	-150.33	195.43	-152	185
29	7.34	271.29	16	248
30	-131.92	174.32	-126	166
31	-140.06	269.74	-140	254
32	-69.98	336.71	-70	317

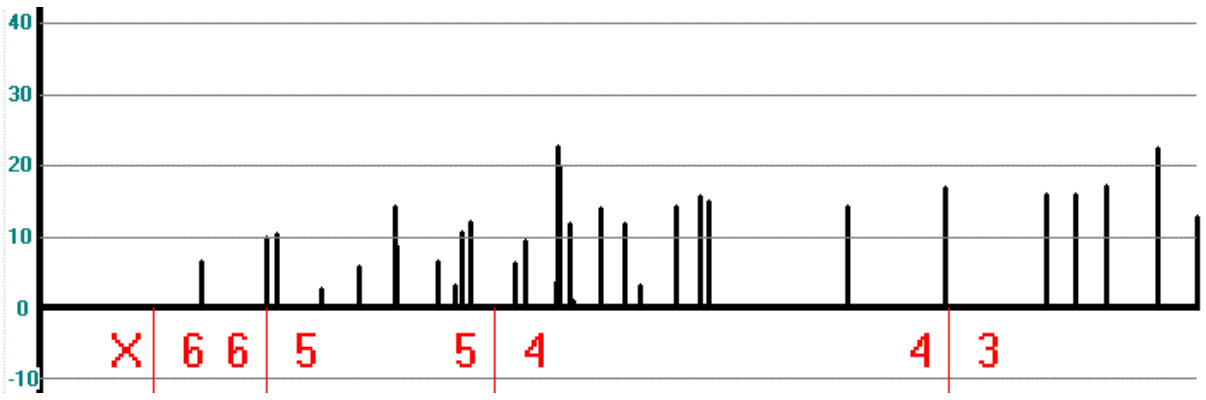
RAW MEASUREMENTS in mm

SHOT POSITIONS



Grid in minutes and half minutes (800m)

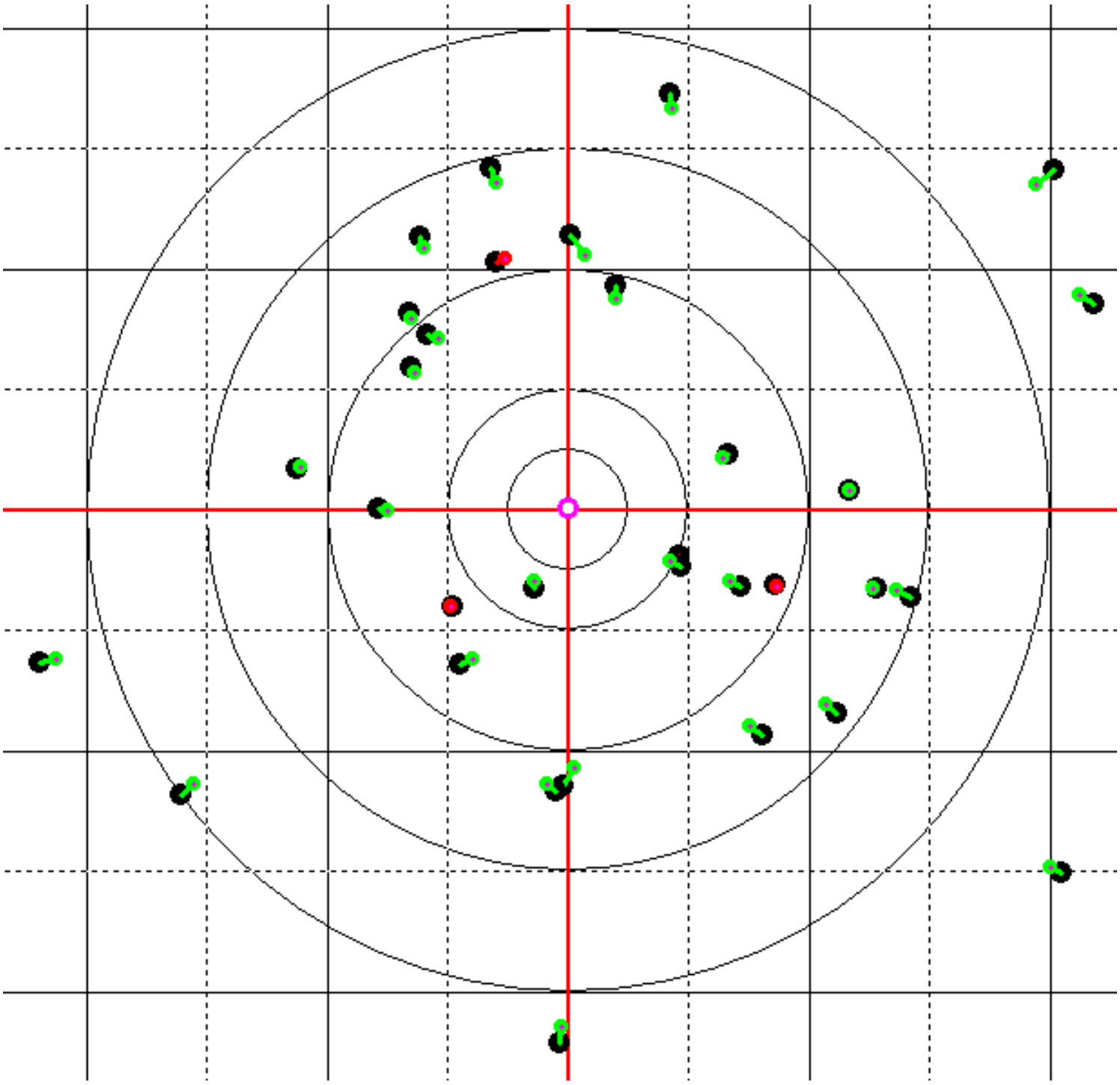
CENTRED ERRORS



X, 6, 5, 4, 3 indicate Score or how far shot is from the centre.

BARS ARE REAL ERROR SIZE

X err	Y err	R err	Lin err
3.71	0.9	-3.54	3.82
13.51	4.92	-12.99	14.38
8.8	0.04	-8.8	8.8
-4.95	-2.98	-5.76	5.78
3.12	-9.42	7.95	9.92
9.12	2.65	-1.23	9.5
2.32	-14.02	-13.55	14.21
-11.3	8.52	-13.34	14.15
10.26	17.28	-18.72	20.1
0.95	6.55	-5.14	6.62
2.17	-2.46	2.97	3.28
-9.43	5.18	-10.76	10.76
-3.31	-0.49	-3.05	3.34
-9.25	4.87	-10.26	10.45
0.51	15.87	-15.85	15.88
-2.6	-0.96	2.73	2.77
-9.56	6.91	-4.67	11.8
13.18	10.74	-16.9	17
15.57	3.09	-15.85	15.88
-1.07	0.28	-1.04	1.11
-11.88	7.89	-14.12	14.26
-13.68	6.26	-14.85	15.04
-14.93	8.59	-10.09	17.23
-17.08	-14.66	-22.48	22.51
3.71	-5.37	-6.14	6.53
-11.04	6.43	-12.64	12.78
-0.19	-12.16	-12.16	12.16
2.4	-5.84	-5.8	6.31
12.73	-18.7	-20.15	22.62
9.99	-3.73	-9.73	10.66
4.13	-11.15	-11.5	11.89
4.05	-15.12	-15.61	15.65



Grid in minutes and half minutes (800 m)

SMT CAIRNS 7mm SAUM 800m 32 SHOTS PERFECT SETUP

d	Ax	Ax SET	Ay	Ay SET	UPRIGHT	RIGID	Vo (LR)	Vsmt	Vcalc	Vo SD	Predicted Target V SD	SMT V SD
800m	8 mil	8 mil	47 mil	47 mil	PERFECT	PERFECT DEAD CALM	2926	1898	1881	6.0	4.8	17.5
							Mean	mean	mean			

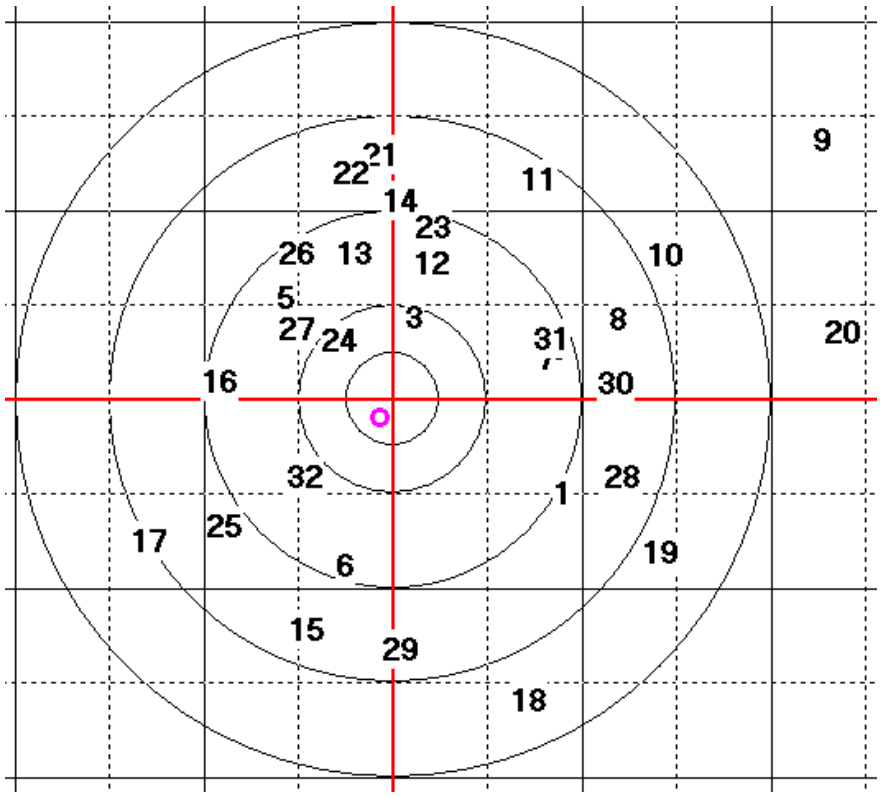
Y SPAN 693.84 mm
CENTRE FITTED REPORT
X CENTRE SHIFT 8.27 mm
Y CENTRE SHIFT 20.26 mm
Shown Further from Centre 1
Shown Closer to Centre 30
SDx 6.99 mm
SDy 4.91 mm
MEAN (mm)SD (mm)
LINEAR ERR 7.75 3.59

<<< *Estimated discarding the Gross Error*

Berger 180 Hybrid Projectile
SMT Temp 29-30 during firing
Fri Oct 27 2017

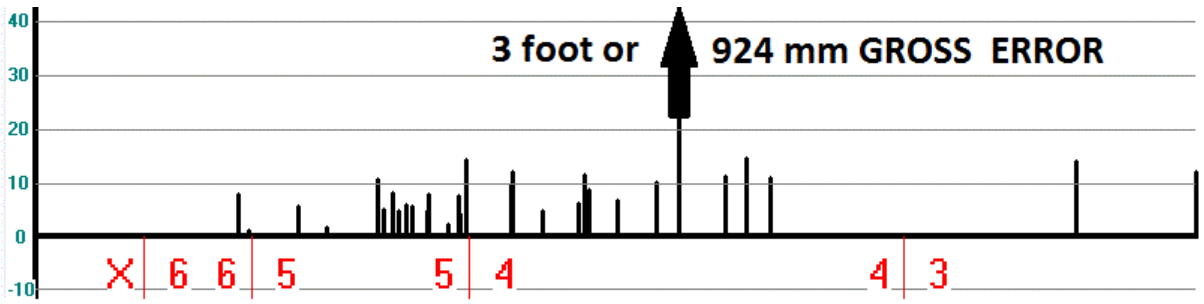
No	Impact X	Impact Y	Monitor X	Monitor Y
1	213.71	-84.41	193	-101
2	204.28	95.1	193	77
3	30.05	133.08	22	113
4	-129.6	149.05	-132	126
5	-127.97	157.56	-127	135
6	-54.41	-172.95	-58	-189
7	192.87	83.33	181	62
8	283.74	132.27	273	112
9	536	353.5	520	325
10	340.06	210.06	319	194
11	183.9	304.77	169	278
12	50.39	199.89	51	172
13	-45.12	213.4	-52	187
14	11.58	277.06	6	247
15	-103.42	-253.76	-108	-263
16	-212.76	54.09	-218	35
17	-298.43	-144.05	221	595
18	171.05	-340.34	159	-351
19	333.69	-157.46	317	-172
20	560	115	539	93
21	-12.26	333.97	-14	309
22	-48.85	312.79	-49	289
23	52.38	245.14	41	225
24	-62.67	105.11	-62	83
25	-205.25	-124.83	-201	-141
26	-115.45	213.4	-115	191
27	-115.62	118.55	-121	97
28	287.3	-64.6	275	-82
29	12.19	-277.66	0	-291
30	278.95	51.87	268	34
31	199.79	108	185	87
32	-106.33	-64.89	-108	-83

RAW MEASUREMENTS in mm



SHOT POSITIONS
Grid in minutes and half minutes (800m)

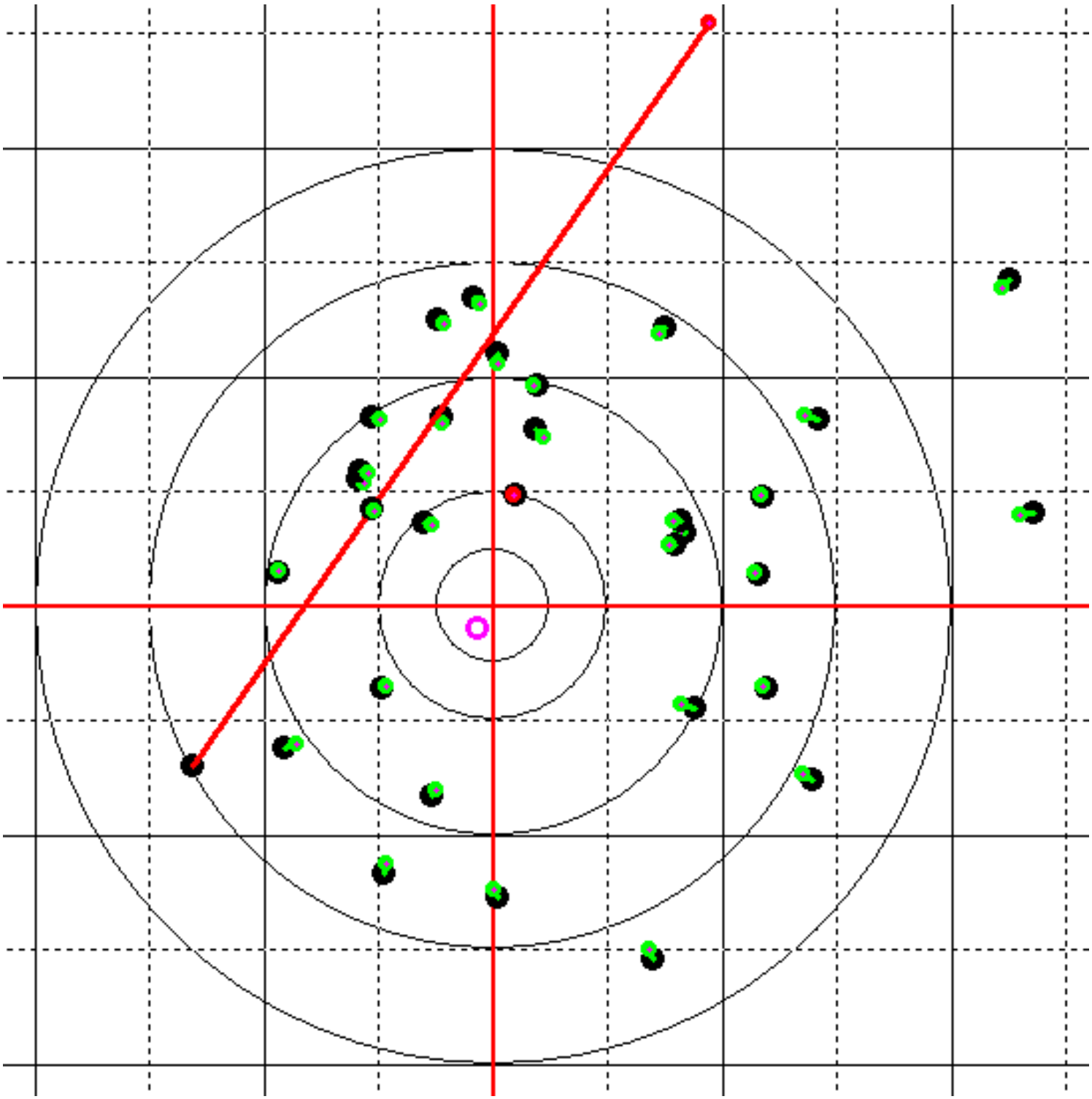
CENTRED ERRORS



X, 6, 5, 4, 3 indicate Score or how far shot is from the centre.

BARS ARE REAL ERROR SIZE EXCEPT FOR HUGE GROSS ERROR

X err	Y err	R err	Lin err
-29	-20.06	13.98	14.26
-20	-21.57	3.12	4.91
-16	-23.55	-0.21	1.13
-11	-26.52	5.09	5.26
-7.26	-26.03	7.01	8.23
-12	-19.52	5.26	5.61
-20.1	-24.8	4.88	4.94
-19	-23.74	3.38	3.75
-24	-31.97	11.88	12.04
-29	-19.53	9.87	14.74
-23	-30.24	9.48	10.09
-7.62	-31.36	5.16	10.61
-15	-29.87	5.72	5.9
-14	-33.53	9.53	9.66
-13	-12.71	11.34	11.52
-13	-22.56	1.52	2.26
511	735.6	-288	924.15
-20	-14.13	11.05	11.06
-25	-18.01	11.36	11.38
-29	-25.47	14.05	14.08
-9.97	-28.44	4.74	6.9
-8.38	-27.26	4.45	7.6
-20	-23.61	0.47	4.39
-7.56	-25.58	6	7.84
-3.98	-19.64	11.71	12.05
-7.78	-25.87	5.53	7.69
-14	-25.02	1.92	1.93
-21	-20.87	5.97	6.14
-20	-16.81	7.21	8.84
-19	-21.34	3.61	4.75
-23	-24.47	7.28	7.81
-9.9	-21.58	5.69	5.84



Grid in minutes and half minutes (800 m)